NEGOTIATING OPEN SOURCE SOFTWARE ADOPTION IN THE UK PUBLIC SECTOR

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Abstract

Drawing on two case studies in the UK public sector our qualitative study explains how and why open source software has seen such a mixed response. Our narratives indicate that for both cases there was strong goodwill towards open source yet the trajectories of implementation differed widely. Drawing upon ideas of change(ing), mutability and materiality we unpack the process of adoption. The study shows that open source software has certain facets; code, community, coordination mechanisms, license and documentation. Each facet is not stable; indeed, it is changing and mutable. This creates possibilities, potential but also recalcitrance, and barriers. The interesting point of departure of our study is how open source software – a much touted transparent and open phenomenon – is by its nuanced and layered mutability able to make the process and practices surrounding it less visible. It concludes with clear policy recommendations developing from this research that could help to make open source adoption more sustainable in the public sector.

Keywords: open source, public sector, mutability, materiality, procurement, adoption, policy implications

1 Introduction

Open source software (OSS) implies openness of the source code thus making it possible to change, and improve the code (Scacchi and Alspaugh 2012; Singh and Phelps 2013). In effect open source encompasses certain freedoms that are embedded in the license of the code (Stallman 1999; Stallman 2002). Open source software and its development process have a number of key elements such as *license* (Benkler 2002), *community* (O'Mahony and Ferraro 2007), the *code* (Fitzgerald and Feller 2002), *coordinating mechanisms* (Crowston and Kammerer 1998), and *documentation* (von Krogh et al. 2003). This characterization of OSS highlights how a) these characteristics together amount to a fuller understanding of what is meant by open source software, and b) that these characteristics are not fixed but instead changing, in flux and unpredictable – even within the same project. Such an understanding of open source helps to reveal how (and if even) OSS mutates within a project or over time. This mutable potential of open source urges research in this area for both theoretical and policy level implications. How, if it all, does the mutable nature of open source impact practice and the work of managers in the public sector? Taking an uninformed perspective on open source adoption in an

organization where the managers believe that open source is a 'fixed' idea that is not open to interpretation, but also very stable over time could lead to naïve decision-making. Our work has implications for theorizing the elements of open source software, and clear policy recommendations for practitioners in the public sector.

Research on open source has developed considerably over the last decade (Aksulu and Wade 2010). There is however a need for more conceptual studies of public sector adoption of open source software. In this paper we examine the process of open source software adoption by two different local councils in the UK. The overarching policy and directive stemming from central government in the UK promotes the idea of open source software use, open data, and open standards. What our study reveals is how this message can become blurred and even engineered through a subtle manipulation of open source software. Indeed, open source software, like other technologies packs and makes invisible the various political logics of policies, design, and code (Bouras et al. 2014; Cordella and Iannacci 2010).

The main aims of this paper include a) theorizing open source software through its internal facets such as license, and code along with its external characteristics such as community, documentation and coordination mechanisms, b) to draw on these open source driven conceptual ideas to understand open source adoption (possible) manipulation in the public sector, and c) to derive policy recommendations that could make manipulation more visible. We thus unpack the adoption and procurement of open source software by two local councils in the UK sensitized by ideas of becoming (Tsoukas and Chia 2002), mutability (Mol and Law 1994) and materiality (Dugdale 1999; Faraj and Azad 2012; Leonardi and Barley 2008). We recognize and show how the becoming (complicated, uncertain, never stable or complete) of OSS adoption indicates that the process of becoming occurs at different speeds (Colville et al. 2012).

Our main theoretical contribution is an explanation of how the *speed of becoming* is managed and controlled and can be purposively directed through facets of open source (code, community, license, documentation, and coordinating mechanisms). Our narrative shows how management in the local councils reined in (or otherwise) the process of becoming via material instantiations of OSS. The nature of materiality was manipulated in both cases to different ends, and results. Our main policy contribution in this work is a set of clear recommendations for public sector officials and central government to make open source adoption more useful and cost-effective.

Section 2 provides background literature to this study and contextualizes our work, section 3 details the methods adopted to collect and analyse data, section 4 provides background on our two cases, section 5 is the findings, the discussion and implications are in section 6, and section 7 refers to the limitations of this study and future research.

2 Open Source in the Public Sector

Adoption of software and IT often does not follow a well-laid out plan and every context is quite different. Context, as argued by Robey and Sahay (1996) plays a very important role as technologies are adopted and used in situ and thus need to be studied as such. This not only forces us to take note of

specific differences in each case but makes generalizability difficult. Most of the studies of software adoption in the public sector are evidence that a certain amount of drift is usual (Ciborra 2000) and perhaps even necessary as the adoption process grows in acceptance at the individual and collective level (Feilner 2013). There are a number of detailed studies that take a cultural perspective on software adoption (Barrett 1999; Cabrera et al. 2001; Jackson 2011). A significant and deeply engaging study of ICT use in the public sector by Bovens and Zouridis (2002) examined the role played by law, and how this role was unconsciously being taken over by software developers. The premise of their argument was that code was beginning to play the role of law as most infrastructure was software intensive, and it dictated what was allowed or not. Near the end of this paper the authors also touch upon the idea of transparency through code and algorithms but leave us with the tantalizing question of, "Which interpretation of the rules is exactly concealed in the algorithm?" (Bovens and Zouridis 2002) (p183). We begin to answer this question in this study.

However, most IT adoption studies usually focus on workarounds as a manner of performative adoption (Feldman 2000; Gasser 1986; Monteiro et al. 2012; Orlikowski 1996). Such work has always kept users as central. This paper is not an adoption study in the conventional sense of user adoption. The aim of this paper is to understand higher level procurement decisions where decisions are made by strategists, top IT managers and policy writers so users, unlike for Boudreau and Robey (2005), are not our *only* focus. Instead, we look to literature on procurement of open source and primary adoption of open source software (by IT staff and developers), *and* secondary adoption by users (Fitzgerald et al. 2011).

Open source adoption in the public sector has seen some growing interest in IS journals (Cassell 2008; Hamel and Schweik 2009; Maldonado 2010; van Loon and Toshkov 2015). There are also a number of interesting conference papers that are beginning to shape our understanding in this space (Allen 2010; Davini et al. 2005; Jokonya 2015; Shaikh and Cornford 2011b; 2012; Souza and Zwicker 2001; Zuliani and Succi 2004a; 2004b). Some work on the commercial adoption of open source software speaks strongly to a practitioner audience. This is essential and much needed, but we find it equally relevant to build a body of theoretical work that helps to explain open source adoption (or not).

An example of a practitioner and managerial perspective can be found in a study based in Australia (Goode 2005). This work draws our attention to some of the key challenges faced by companies when choosing between open source software and proprietary products. Goode (2005) argues that in many cases managers decide against open source on the basis that if it is cheap or free of charge then it can't be very good software. There is indeed such a bias where what has little monetary value is seen to then equally have no other value or use (Fitzgerald 2011). Amongst the other reasons for managers deciding not to adopt open source software for their company needs included a possible lack of software support (delivered in a professional and efficient manner), a steep learning curve to the use of this software, staff unfamiliarity with the software, Microsoft seen as the easier interface by comparison, reliance on old and legacy systems that were unable to interface smoothly with open source software, and even an inability to see any relevance of open source software for their company needs. And though these issues are cited by companies and managers in commercial organizations they are equally true of the public sector (Rossi et al. 2012).

2.1 Broader Reasons for Public Sector Interest in Open Source

Procurement (Phipps 2011) and acquisition decisions by many governments are currently under question, and greater scrutiny has led to governments in the European Union, UK, Australia (Archer 2010) and the USA (Kundra et al. 2011) to amend their habits. Research to date in the area of open source use and adoption in the public sector, though growing, is still quite patchy. A UK based study (Waring and Maddocks 2005) focused on eight different local councils and agencies. This work outlined a number of concerns and key areas that need improving in the public sector before successful adoption can emerge. This was however, a high level study where details of each case and the various struggles were not the focus.

Likewise in the US, studies have shown open source use adoption needs top level support and encouragement for success (Oram 2011). This was equally true of the study carried out in Cuba where the authors recommended that if governments are to traverse the gap between policy and implementation of open source software then top level political backing is a necessity (Garcia-Perez et al. 2006). Brazil is a different but another very interesting case where the success of open source adoption has been explained and emphasized as a product of insurgent experts (Shaw 2011) who had political strength (Cassell 2008; Nasi et al. 2011; van Loon and Toshkov 2015) as the 'insurgents' were part of the elite intelligentsia of Brazil and thus in a better position to exact change.

The European Commission has an explicit directive to promote software alternatives (Ghosh et al. 2010), especially open source software. The European Commission has established a collaborative platform called Joinup[1] where numerous interesting and reflective cases of open source adoption across Europe are accessible. These have been written by authors from academia, public sector officials, think tank researchers and consultants. Some cases that stand out in their specific interest to the current study and for their novelty include the Extremadura case in Spain (O'Sullivan 2013), the French Gendarmerie (Bierhals 2009), and Camden Council in the UK (Ballard 2013; Mangham 2005; Offerman 2012). And very recently, the UK Government's Cabinet Office (Ballard 2011; Hall 2011; Saran 2010) met with the large and influential system integrators to declare a greater need to have open source choice offered to the government. The argument put forward by the Cabinet Office was that the government was unable to choose open source as an alternative if this was not offered as an option by the integrators. Open source software, along with open data and open standards is fast becoming part of the language that governments all over the world are eager to adopt (Burkhardt 2008). It is, for example, one of the basic building blocks of the US government in relation to its encouragement of its open government initiative (Noveck 2011).

The USA has seen real progress with respect to 'open' – with the two-time election of Obama we can note the strong backing for open government (Harrison and Sayogo 2014; Noveck 2011; O'Reilly 2010; Wijnhoven et al. 2015; Yu and Robinson 2012), open data (Conradie and Choenni 2014; Gurstein 2011; Janssen et al. 2012; Kassen 2013; Linders 2013; Sieber and Johnson forthcoming; Veljković et al. 2014; Zuiderwijk and Janssen 2014), open source adoption (Allen 2010; Davis 2012; Fitzgerald et al. 2011;

[1] https://joinup.ec.europa.eu/

Lundell et al. 2010; Oram 2011; van Loon and Toshkov 2015) and open standards (Fishenden and Thompson 2013; Gamalielsson et al. 2015; Ganapati and Reddick 2012; Shah et al. 2008; Simon 2005; West 2007).

Open source software is seen as part of the easing of recession and costs of IT in the public sector in the UK (Fishenden and Thompson 2013), and elsewhere (Bouras et al. 2014; Bouras et al. 2013; Cassell 2008; Pedersen and Huniche 2011). However, as the UK government is aware, open source software is still a rather unknown phenomenon. The true and complete costs involved with switching to another software, be it open source or not, are not easy to evaluate (Russo and Succi 2009). Open source software further complicates matters with close to zero license costs, but this does not necessarily translate to lower costs in other aspects (Gallopino 2009). Indeed, the costs of ownership can go up in the short-term (Shaikh and Cornford 2011a) and exit costs need a full evaluation if expectations are to be managed (Shaikh and Cornford 2011b).

There are a few studies that stand out in their emphasis on providing a methodology of open source adoption in the public sector (Bates 2014; Bouras et al. 2013; Fishenden and Thompson 2013; van Loon and Toshkov 2015; Zuiderwijk and Janssen 2014). We found the work by Bouras et al (2013) particularly insightful because they offer a comprehensive methodology comprised of four overarching issues: technological, organizational, economic, and finally social. Each of these elements consists of a host of fine-grained characteristics that make application to different contexts straightforward and comparable. However a few characteristics that we found to be very significant in our study but are missing from their framework include issues of vendor lock-in and exit costs. We will return to these and other ideas in our policy implications section later (see section 6.4).

2.2 A 'Relational' Perspective on Open Source in the Public Sector

Private companies (Agerfalk and Fitzgerald 2008; Rolandsson et al. 2011; von Hippel and von Krogh 2003) tend to adopt open source software for a mix of reasons which clearly include the promise of reduced costs of adoption (Marsan et al. 2012), but there is often a strategic aspect (Ceccagnoli et al. 2012; Kilamo et al. 2012; Watson et al. 2008), as well as a strong desire to innovate (Bouras et al. 2014; Shaikh and Cornford 2011c; Sutor 2009). The public sector would like to enjoy these benefits as well but till very recently the desire to innovate was not foremost for most governmental agencies. Public sector organizations are not profit orientated yet there is much to learn from private companies and their manner of dealing with open source. The larger idea here is the level of experience and comfort that private companies bring to open source adoption which is sorely lacking in the public sector, and which the public sector is well placed to take advantage off and spin into multiple advantages (Rossi et al. 2012). There are some exemplary cases of open source adoption by the public sector like the Extremadura case in Spain (Zuliani and Succi 2004a; Zuliani and Succi 2004b) but there are far more 'success' stories of open source adoption by commercial companies (Dahlander 2007; Dinkelacker et al. 2002; Fitzgerald 2006; Hauge et al. 2010; Lundell et al. 2010; O'Mahony et al. 2005). What we found missing in the literature was attention to the role played by politics within and external to public sector organizations attempting to adopt OSS.

Finland provides an example of early adoption of open source within the public sector. A quick search for case studies of adoption on the Joinup site will elicit numerous examples in different cities. This includes software for e-government services, online education software, electronic invoicing systems and library systems (to list a few). A study by Freeman (2012) of the Finnish public sector's decision to adopt open source software is of particular interest to our work because it is a rare example of looking for politics of technology (Winner 1986), or more specifically in Freeman's paper, power in and through discourse about open source in different public sector organizations. Drawing on Fairclough's (1995) ideas of change through discourse Freeman explains how open source took on four distinct discourses over time. They include a discourse of economic-technical efficiency, of governance and regulation, of an idealistic open source user, and of an ordinary office software user. A multi-stakeholder perspective taken on open source adoption decisions in San Francisco yield a slightly different understanding of the implications of open source adoption (Allen and Geller 2012). This socio-technical (Winter et al. 2014) study explains how the innovative capacities of open source helped to change the relationship between the IT staff and users in three different projects in the public sector. This was rendered possible because of the joint sense-making that was necessary when customizing and adapting open source software for contextual use.

Sometimes sense-making comes in the form of a clear decision to reject certain software. The Belgian example of attempted adoption of OpenOffice in the public sector provides a strong example of when users and the IT staff jointly decided that OpenOffice just wouldn't work for certain segments of the agency (Huysmans et al. 2008). This was explained as a case of a lack of functionality of OpenOffice compared to other products that employees were in the habit of using, but also as an example of when certain packages simply don't have the requisite functionality for the specialist needs of specific users.

Another interesting study of shared learning through the customization process of software in the public sector in Ethiopia brings us closer to our relational perspective on software and open source development (Mengiste and Aanestad 2013). This study has some elements of open source (as the software being customized is OSS) but it tends to largely ignore this aspect and focus instead on the tensions and negotiations necessary to bring about shared social worlds. The relational focus on technology is close to ours as is the interest in the politics of technology (Contu and Willmott 2003; Winner 1986). A very nice analysis in this paper on the slightly different perspective of boundary objects as artefacts that push tensions and thus negotiations to the surface drew our attention. We would however, like to focus more particularly on the materiality of software, indeed that of open source software as this study like many others either ignores that there could be something distinctive about OSS, or treats technology more generally as a tool (Orlikowski and Iacono 2001).

2.3 Conceptual Underpinnings

This research is guided by a relational ontology (Deleuze and Guattari 1987) where information technology and users are not defined outside their relationship but in their relational networks (Latour 1999). This consideration moves the focus of the analysis from the actor, either human or non-human, towards a more complex and less defined phenomenon, which is the interaction (Callon 1986a; Callon

1986b; Latour 1988). It has a "relational materiality" (Law 1999). Drawing on this perspective we understand that successful software adoption is never a certainty, but we are also able to trace successful and unsuccessful possibilities of the software. The relevance of such an approach lies in its ability to unpack various criteria, actors, relations and material considerations that a simple adoption study would do little justice to as 'performativity leaves open the possibility of events that might refute, or even happen independently of, what humans believe or think' (Callon 2007) (p323)

The idea is that all around us is in continual, often difficult to discern change or becoming. Becoming is not a specific state but rather a focus on movement from the then to now, not a move from one state to another. It reflects a passing of time and a process, 'becoming thus sees the idea of an organization's existence not as an ontologically stable, but rather as something that exists only in its duration' (Clegg et al. 2005). It is in this becoming that organizing materializes with a focus 'on movement rather than that which is moved' (Clegg et al. 2005) (p159). The previous tradition of change studies has been criticized for focusing on stability in order to understand change (Feldman 2000; Orlikowski 1996; Weick 1998). This suggests the need to reverse 'ontological priorities' (Tsoukas and Chia 2002) and for keener perceptions of the ongoing nature of change or 'changing' (Weick and Quinn 1999). This reversal is helpful not least if it allows a better understanding of the micro-processes of change, treats change as dynamic and unfolding rather than as a fait accompli, and makes it ontologically possible to 'see' change by directly looking for changing, rather than as a byproduct of some comparative stabilities (Tsoukas and Chia 2002). Thus in developing the concept of *becoming* Clegg et al. (2005) emphasize the focus on movement, not on what has moved or where it arrives (at best mere snap shots, moments in time); becoming is about travel and mutation rather than what has mutated. Stability is then at best fleeting but more likely to be illusionary; change is reality.

Drawing on various interpretations of organizational change (Feldman 2000; Orlikowski 1996; Weick and Quinn 1999) Tsoukas and Chia (2002) argue that improvisation within a context is somewhat narrow in recognizing the prevalence of change, changing routines focus solely on human agents and agency, and any and all collectives and organizations never quite become, and indeed are in a constant form of changing (becoming). And becoming is performative (Feldman 2000; Tsoukas and Chia 2002) where performative (Austin 1962; Butler 1997; Law and Singleton 2000) implies that something becomes into existence and has effect and materiality through action and performance – action through words, movement or some more abstract change is needed.

Becoming implies an ontological understanding where the world (reality) has a middle but there is no beginning or end. Reality is not seen as hierarchical but rather as a rhizome of multiplicities that can and do fracture, rupture, and entangle. Such an ontological position creates an imposition on the researcher to make a methodological cut into reality where Law (1999) has argued that attention to differences and interactions can become that cut. The desire to understand the status quo does not mean we must have a static view of the world (Bateson 1972). The trapeze artist walks across the tightrope appearing to be not doing very much and keeping straight, however this keeping upright requires many muscles and nerves are in a constant flux else the artist would fall. In an organizational setting this form of changing occurs all the time but is difficult to perceive. Thus an ontological understanding that

becoming brings with it nudges the researcher to focus on ruptures as an epistemological tool to cut into the data and allow the changing to emerge for us.

Our research was thus motivated by a desire to make sense of open source software adoption while deliberating on politics, change as a complicated (multifaceted) phenomenon and other heretofore ignored actors. More specifically we were driven by a need to understand how open source software adoption was being managed by public sector organizations and why, when the circumstances and reasons for adopting open source for both councils were so similar the results were so very different. Thus, our main research question is: *How can and is open source software mutable and manipulable in organizational adoption?*

3 Methodology

We chose two local councils within the UK, Camden and Bristol City. Our choice was dictated by their deep and long interest in open source software where they had experienced rather different results to date. Similar to other studies where two case studies had been explored (Ghemawat and Khanna 1998; Keen et al. 1982; Motwani et al. 2002; Schonberger 1981) we chose two rather than one on the basis that both cases were a) involved with open source adoption and b) that they both had undergone different experiences of success. The ability to analyse data across more than one case also provided us with a check of robustness of our claims. Commercial interest in open source software started to take real form in the mid-2000's, and in the UK the public sector only showed practical interest in it a few years ago. It takes time for change to trickle into the public sector so we decided to find cases of open source adoption and interest that had some activity from 2005 onwards. This ensured that we would learn something of the process of open source adoption no matter where the project stood today. Both Camden and Bristol stood out within the UK examples in that they had shown deep interest and worked with open source software for a decade or more. They were also large local councils with multiple open source projects running concurrently.

Both councils agreed to provide us with access (which partly dictated our decision to focus on these cases) and also gave us access to internal documentation concerning their open source decisions. Media had also written various accounts of both cases over the years. We scanned newspapers, magazines and other online material to help us build an account and storyline. In the case of Bristol the accounts were rather strange as they continually switched between positive and negative renditions of the status of open source adoption. Camden was less visible in media reports yet our own attendance at certain policy level meetings in the UK Cabinet Office had indicated the deep level of expertise that members of this council reflected during discussions, and were clearly respected for.

3.1 Data Collection

Three methods of data collection were used for our study. We carried out in-depth, semi-structured interviews with core personnel in each organization, there were site visits and observation studies, and we studied media reports of the open source narrative for both councils. We began with the media reports because it helped to provide us with background on both of the cases. We used this as the basis

to build our interview guide. We conducted 32 in-depth one-off interviews over the course of November 2010 to April 2012 (but team leaders were interviewed multiple times – 35 interviews total (Charmaz 2002). The personnel interviewed ranged from the open source policy writer in both council organizations, IT and developer team staff, floor-walking members, users, and strategy level staff, but also those involved in making procurement decisions and strategy of open source use in the organization. Most of our interviews lasted for over an hour, and there were a few with team leaders and policy writers that stretched beyond four hours each. These long interviews were in most cases the first interviews held and the interviewees were supportive enough to take us through very detailed historical narratives of open source adoption in their organization.

Our short interview guide covered questions relating to basic information about the length of open source adoption, and the role of the interviewee in the process to more detailed examination of obstacles, opportunities, and challenges involved. The latter we used as 'rupture' points to access the story and unpack the process of change(ing). The main ideas the respondents focused on included the lack of maturity level of open source software, there being no clear policy in most councils for open source adoption, license confusions and lack of knowledge about the implications of various open source licenses. Another level of our interview questions probed issues of what it means to be open, open source and develop software with an open source process. Such a line of questioning was inspired by our first few interviews across both councils. We were both intrigued and a little surprised by how hard such questions had been debated by the practitioners, and this was obvious from the different answers we were given in relation to challenges of open source development, adoption and implementation. We followed up these concerns with team leaders (but also with the floor walking teams) in our second round of interviews.

We made site visits for Camden Council, and interviewed various employees over a few days. The team leader for Camden Council was interviewed on three different occasions during the course of our data collection. He was a key player in promoting open source use and development in Camden Council. The first interview with him lasted for over four hours where he provided chronological background on Camden's introduction to open source software. The researcher then followed up on this interview with a detailed report and table with a temporal breakdown of events. The team leader then made some necessary factual corrections to the timeline. He then helped to set up interviews with other members of his team and council colleagues. During the course of the week spent visiting Camden Council the researcher met and interviewed a strong and mixed representation of employees. The team leader was interviewed again during this visit. A few months later, when the researcher had had time to go through all the notes, interview transcriptions and media reports on Camden Council, it became necessary to ask some clarifying questions but to also discuss strategy and other challenges faced by Camden. The team leader was then interviewed for a third time.

Bristol Council was approached through its team leader at a UK Cabinet Office meeting on open source use in the local government. The leader was interviewed twice by the researcher. The initial interview, lasting about three hours, was carried out in early 2011 but actual access to the council took a number of months to negotiate. There was finally an agreement to carry out phone/Skype interviews instead of

a site visit. The first group of phone interviews were organized for the researcher by the team leader but then the researcher used the opportunity of requesting more names of involved personnel from each successive interviewee. This became an effective way to speak to personnel that were more mixed and divergent in their views. The team leader was interviewed again over the phone at the very end of this process. This was done for clarification purposes, but also as in the Camden case, to seek explanation of troubling notions such as the real meaning of open and if it was any different in the public sector. A timeline was also created for Bristol's interest in open source and sent to the team leader (as in the case of Camden) for verification of factual details.

Each of the methods that we used to collect data had a different but complementary purpose. The relevance of the archival material we accessed was to build background knowledge and to help construct an interview guide. The thirty-five interviews were conducted with different personnel of both councils to get a more comprehensive understanding of the failures (and successes) of open source adoption. We were as keen to get answers from the legal team as the floor walking IT training team. Each of them added value as we began to understand the narratives better. Finally, our site visits were relevant because we were able to speak to the team of programmers *in situ*. We watched as they resolved issues, answered queries and often showed exasperation.

3.2 Data Analysis

All the interviews were transcribed. The researcher had taken detailed notes after each site visit (and even during the visit between interviews). The telephone interviews had also been recorded, and each one transcribed. All the data collected and written up was analyzed (Richardson and Kramer 2006; Strauss and Corbin 1999) systematically using Atlas.ti software. The aim and relevance of coding our data was three-fold because we wanted to a) organize the ideas emerging from the interviews, b) look for deeper, overlapping concepts which unpacked open source, and c) to check the resilience of our initial ideas of both theory and the phenomenon under study (Bryant and Charmaz 2007; Charmaz 2006; Glaser 1987).

Our open code book was populated with concepts from our theory of choice but this book grew as we continued to code the interviews. Some codes had to be renamed, while others were split into more micro ideas. We also deleted 7 out of our 46 open codes as the data did not speak to them. The open coding was carried out in a phrase-by-phrase mode (very finely) for the first ten interviews (Corbin and Strauss 2008). As we progressed through the coding process we noticed that fewer new codes or ideas were emerging so we began to code paragraph by paragraph. Our coding process remained rigorous and we stayed faithful to our data and the ideas emerging from it.

The process of open coding also involved the researcher making theoretical notes (Glaser and Strauss 1967). These were added as memos within Atlas.ti software. The relevance of theoretical memos in coding is to be able to take more detailed notes that related to not only the open codes but also helped to link the various open codes at a conceptual level and build a conceptual narrative (Annells 1996). The main conceptual themes that emerged related to mutability, materiality and openness. We found various interpretations, versions and types of materiality. It was the concept of changing materiality

that created the link between the openness/transparency ideas of open source through questions of mutability.

4 Open Source Software in the UK Local Councils

Both of our case studies are based in the UK where one can now be distinguished by its 'success' (Camden Council) whereas the other (Bristol City Council) has undergone a very mixed engagement with open source. Our reason for choosing both cases was not based on a desire to undertake a comparative study but instead because both cases offered different levels of open source adoption – both primary and secondary. Camden was involved (though not exclusively) in primary adoption of open source (by software developers), and Bristol attempted a blanket secondary adoption of open source (for users). This allowed us to make sense of open source adoption at different levels of an organization. We were intrigued during the course of our data collection by the nature of materiality, the question of what open signifies in open source, and how certain features of such software and development could be managed to produce a particular output.

Our narratives indicate that for both cases there was strong goodwill towards open source. Camden Council guided the open source process internally with a strong manager as leader. He built up a team of IT staff over the last ten years that progressed from simple interest in open source to what is now considered to be an evangelist team of highly skilled developers. Camden co-created on an open source project and is now able to offer its expertise to other local councils that share an interest in moving to open source software and platforms. Bristol City Council was in the media spotlight from the moment it announced its open source intentions. There was a grand move towards open source desktop software use. However, this euphoric open source sentiment did not last for more than a year, after which stories of open source failure began to leak. Open source software was then discarded and Bristol was forced to return to proprietary software. More recently Bristol has shown a renewed interest in open source but this time there is a more cautious approach to such change.

There are many similarities across both cases in the UK and we found it intriguing to make sense of where in this process of open source adoption did open source play a role, and what provoked the failure in one case and the relative success of the other.

Table 1. Chronological Tracing of Open Source Software for CC

Year	Tracing IT/IS Events at Camden Council
2001	Took part in the Pathfinders project by submitting a proposal for an open source content management system which would be reused by other local councils.
2002	CC won some funding for the CMS. A partnership of five local councils began work on the CMS in collaboration with Philip Greenspan of the MIT.
2003-04	Won second round of funding to build an expanded version that had more functionality, be easier to install and would work on an open source database as opposed to Oracle. The CMS was taken up by 30 UK local authorities and then also Australia, Malaysia and China. CC faced growing complexity of working closely with an external open source community with different motivations, deadlines and agenda.
2004	Began to build an ecosystem around their open source projects by enrolling SME help and enthusiasm (and also the funding they had left).

2005	The ecosystem proved harder to maintain as there were not enough tenders to keep the companies afloat. The number of support vendors began to disappear from the market forcing CC to find other forms of support. CC found another academic institution that was willing to work on the CMS.
2006	CC created a validation process for incoming contributions from external sources. CC hired the services of Red Hat to objectively validate the contributions thus creating a meritocratic process of acceptance. CC toyed with the idea of setting up a subscription payment for the CMS but dismissed it considering that this would not be open source friendly.
2005-11	CC now works in conjunction with the academic institution that took up the development of the CMS. The academics nurture the community and manage it. The development is done partly by university students, CC IT staff and some contributions are from external developers and open source communities.
2011-12	CC has a strong team of IT developers and staff that are busy building up open source projects, and expertise. The growing concern is however, that this team and its energy are being nudged towards more maintenance work rather than challenging new open source projects.

4.1 Camden Council (CC)

Camden council and its move towards open source has been led by a strong IT leader who has a reputation for 'doing things differently' (Member of Legal team of CC).

> *"And Alasdair, you know, is pretty radical but our head of IT was constrained by the normal types of thinking of a head of IT in local government, you know, very risk averse, worried about things not being accountable. Worried about anything that wasn't a mainstream type approach. But recently that's all changed. Because obviously everyone is saying this is the way to go etc etc. So I think six years later, seven years later yeah, I think there's an acceptance now that it's the most sensible and when we had a long, very, very long project to even get kicked off, which was, you know, a citizens or a business portal, Alasdair did his own research and went down the open source route but it took two years for us to get to a point where we could actually procure and it also took us paying Gartner" (IT Service Team member).*

The clear objective was to have a content management system which could manage the load of thousands of constituents using the software and where many dissimilar functions were possible through the same interface. The decision to go open source was not dictated by any form of ideology but rather it was a practical decision based on a need a) to work with other local councils and b) cut back on a waste of resources and expertise. Table 1 traces the chronological history of open source adoption by Camden Council.

Camden Council faced numerous challenges with its decision to adopt and co-create open source software in the form of community management, limited funding, a dying ecosystem of SME vendor support, and lack of uptake of the CMS by as many councils as expected yet it has persisted in its endeavour with some good degree of success. It is now seen as an example of how to do open source well, and other local councils look to Camden for support, advice and software.

4.2 Bristol City Council (BCC)

Approximately 15 years ago (1997-1998) the IT staff of BCC was using open source software to support the council's first experiments with websites (see Table 2). There was no philosophy or political backing for open source at this point. It was simply a practical need to create a website that led the BCC IT staff to use open source software options. The interviewees added that there were always 'overtones of being open' but no clear direction or strategy was apparent in the first five years.

Table 2. Chronological Tracing of Open Source Software for BCC

Year	Tracing IT/IS Events at Bristol City Council
1997-98	Open source used to create and host the first BCC website
2001-04	BCC evaluated and selected StarOffice rather than Microsoft products because the former was cheaper. Initial research with local government system vendors indicated that integration with StarOffice would be technically possible, and several key vendors expressed a willingness to do the work necessary.
2005-06	StarOffice rolled out across the council to over 5000 users, supported by 8 person team of floorwalkers and technical specialists, providing document conversion, training and coaching to staff. BCC shared experience and learning from evaluating and selecting StarOffice by publishing guidance documentation via "Open Source Academy", a UK National e-Innovations Project.
2007-08	BCC continued to invest in StarOffice, rolling out version 8 and working with Sun and key third party integration system vendors (ISVs) in the local government market, seeking to establish integrations with a variety of business systems. Vendors began to step back from willingness to do integration work without Bristol contributing significant extra funds, citing lack of market take-up of StarOffice and open document format (ODF). BCC staff shared challenges and options for addressing them with Sun, IBM, and other EU governments interested in the issues in a series of conferences and seminars.
2008-09	Continued use of StarOffice became problematic, as fidelity of file conversion was still not as effective as necessary for problem free "round-tripping" of documents, and lack of system integration meant that a high number of MS Office licenses had to be retained.
2009	BCC adopted a new Information Systems & Technology Strategy and restructured the ICT Service, introducing Enterprise Architecture and establishing a new approach to evaluating and selecting applications and technology to ensure fitness for purpose. Open Standards were made a formal and central part of the strategy at this point. EA team recommended that due to experiences between 2005 and 2009, it was no longer viable to continue using StarOffice, and that MS Office should be adopted. Project created to develop business case and plan.
2010	BCC Cabinet approve business case for adopting Windows 7 and MS Office 2010 on all council PCs, with other elements of "desktop and collaboration" software stack to be selected through a rigorous "level playing field" approach of comparing OSS and proprietary options to business requirements. OSS would be selected wherever it met requirements and provided best value for money. Computacenter and Sirius (OSS SME subcontractor) were taken on as System Integrators to design and deliver the project.
2011	Breakdown of relations between Computacenter (SI) and SiriusIT SME support led to delays in selection and design stages. LinuxIT eventually selected as replacement by Computacenter. Some OSS options were selected, e.g. Big Blue Button for web-conferencing and video conferencing, and Alfresco for team collaboration. MS software selected for other elements, e.g. email, IM and presence management, directory services. EA team led separate series of evaluations and selections for an integration platform, business process management system (BPMS), website, and electronic document and records management system (EDRMS). Open standards based products from Tibco chosen for integration and BPMS. OSS products Drupal and Alfresco chosen for website and EDRMS.

Evaluating various open source options has not been cheap – indeed this part of the selection process was lengthy and consuming in terms of time and various resources. This expense would be more acceptable if it had led to a viable set of OSS options. The issue was that BCC was recommended a package where numerous products were 'sewn together' to provide a solution that did not meet all the functional requirements. While Microsoft offered BCC the usual standard government option – no extra expenses or strings attached – and still emerged cheaper than the OS option. More recently, however the attitude and price offered for open source solutions has changed,

> *"I, in my time here with procurement I've been told we are not allowed to look at open source solutions. And I haven't been told that in the last kind of year. So that, you know, that's a good sign. But I don't think it's being pushed, no" (Member of Legal Team).*

BCC has a roadmap for changes required over the next few years. This will no doubt entail exit costs but BCC believes that with the many companies offering support in migration from proprietary to open source software nowadays there is a clearer idea (and value attached) to exit costs, which makes migration less problematic and fuzzy.

5 Findings

Data analysis through coding of the interviews and other archival material showed us how aspects of open source were analytically separable. The main descriptive codes coalesced on software code characteristics, community, coordination mechanisms, license, and documentation needs. These descriptive codes enabled us to make agential cuts (Barad 2003) into the interview data. We then unpacked how each of the aspects of open source was implicated in procurement and adoption concerns and also how they were understood by the councils. Our conceptual underpinnings made us more aware of how mutability and materiality were intertwined and affected the process of adoption of open source software.

5.1 Source Code

Visibility of the source code in open source software makes it possible to change and customise it. This lends a different form of mutability that is less possible with proprietary software because with the latter most customers are leased a license for a period of time to use the functionality, and that is it. With open source software the code in practice becomes more malleable. It can and does change. Both our councils are examples of primary and secondary adoption of open source software. As such our interpretation of the interviews reflects both levels of analysis.

Open source software *should* be changeable yet in its use by secondary users when they interfaced with users of different packages (usually non-open source) showed the code to be quite *rebellious in its immutability* (Figure 1). It would refuse to work properly and versions of the documents created by users began to change shape in a manner not expected or wanted. A document created or opened in an open source package would often get changed by the user and then passed on to other users. The latter would not all use the same software as the initial user. This would create some disparity in the documents, and the difference only escalated with multiple 'round trips'. Another form of immutability

was evident from the creation of templates in open source software. The IT team fashioned templates for users and added them to the main interface thus making it easier to access and use. This feature was not available in some equivalent proprietary software at that time so this feature was seen by even the most resistant user to be useful. We understood this to be a move from something highly *mutable to immutable* in open source. It seemed to be necessary to curb the ability to mutate and bring it under control for compatibility and ease of use reasons. Building a more useful and 'generic' interface was a persuasive mechanism to undermine the growing resistance of open source use in the public sector.

Indeed, various forms of mutability found in open source code and how it was understood through association reflects an annoyance amongst the users and developers alike in the councils. The developers complained of *mutable support* where it was increasingly difficult to value how much to pay for open source support. Vendors realized their strategic position in the market. Open source use was not matched by good support services and it was not easy to hire good open source talent. Such opaqueness made adoption of open source quite questionable for anything other than the most generic and infrastructure products. Developers were also overwhelmed by the *multiplicity of mutability* possible in open source software development. The code is visible to all the developers and so in principle and practice there are numerous versions of similar code available at one point in time. Innovation may be fuelled in this manner but in order to consolidate ideas and package them neatly for stability in code the developers had to seek the most appropriate version or customise it themselves.

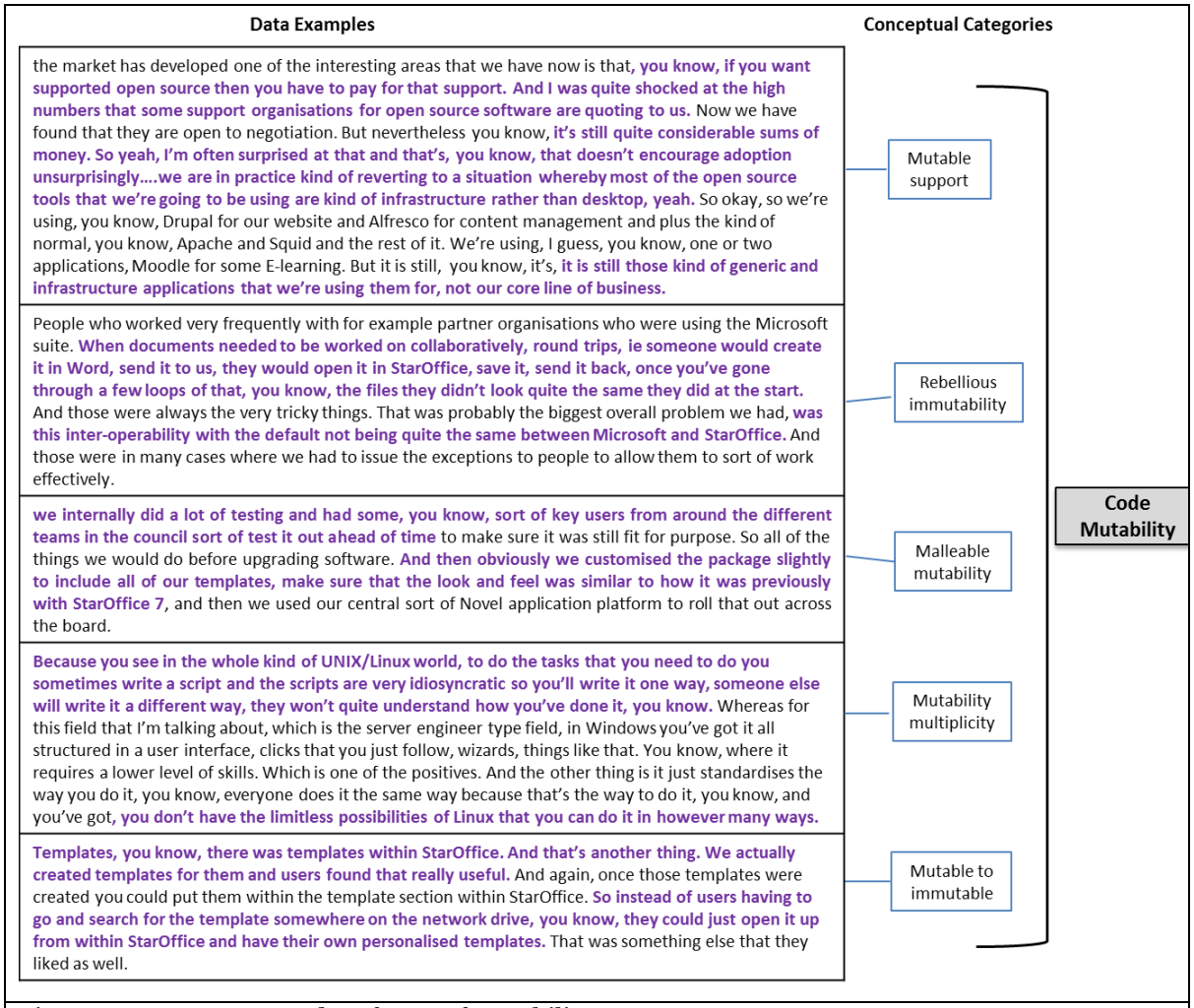

Figure 1: Open Source Code – forms of mutability

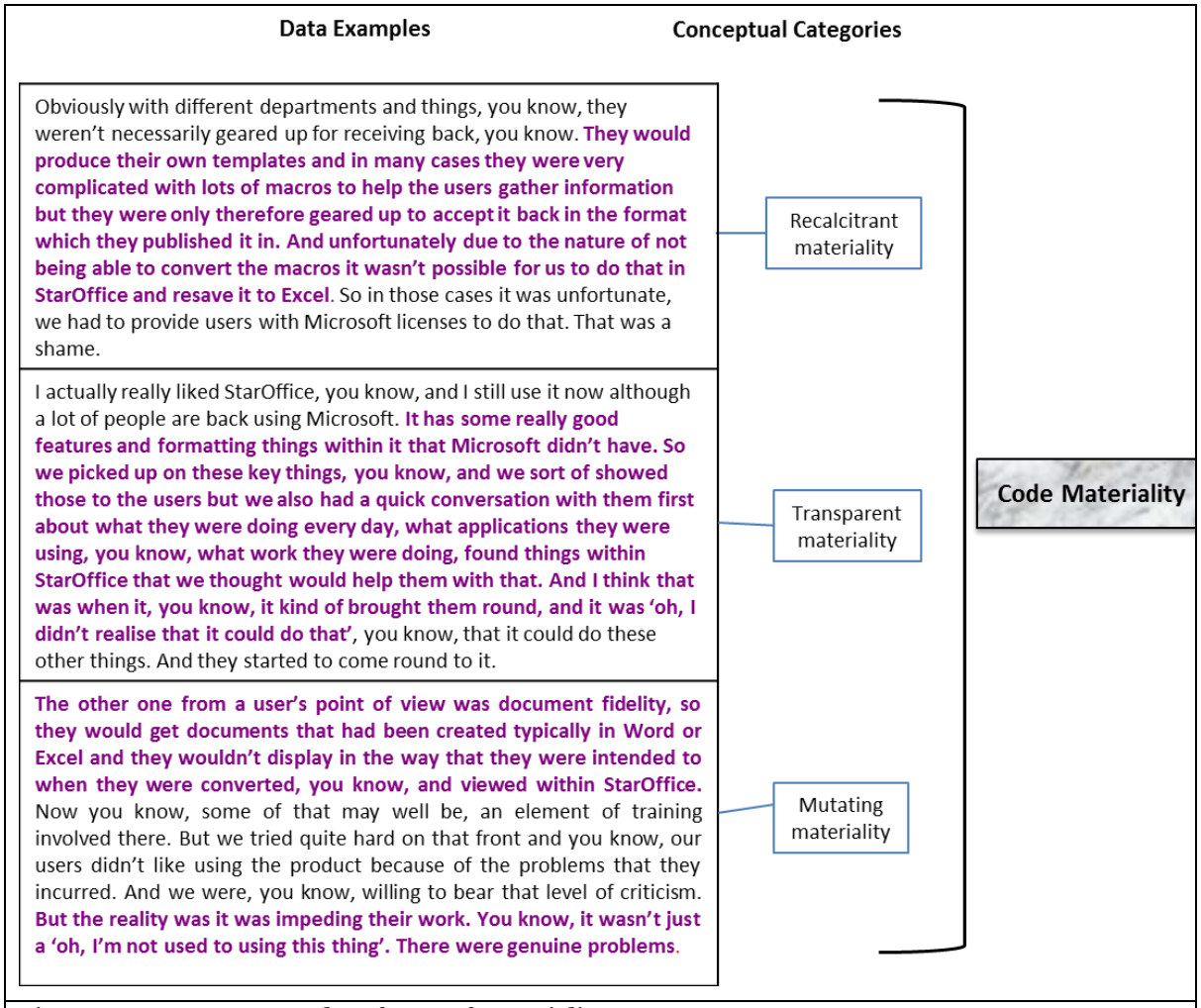

Figure 2: Open Source Code – forms of materiality

The material nature of code – ie that it not only performs and functions but also has a more traceable nature – brings interesting interpretations of open source to the forefront (Figure 2). When document fidelity failed during its round trip journey between open source and proprietary packages (and back again) the clear trace left was the inability of users to either open their documents anymore, or to be able to read them in any sensible manner. Such *mutating materiality* of the documents through the underlying code created tension between the users and floor walking staff. Eventually, the latter were forced in both councils to return the users to proprietary packages of their choice. The code was *recalcitrant* because it was not able to cope with the interface with proprietary software. This did not imply that the materiality was not transparent. To the contrary, the floor walking team were, with certain types of users, able to convince and persuade through the *transparent materiality* of certain features like useful templates, access to photos and symbols (that at that time were not available in non-open source software).

5.2 Coordination

Coordination is always an organizational concern but when this involves different organizational forms to operate together it can become more problematic (Figure 3). Both councils needed to organize work

within their own (very large organizations), with other local councils, central government, citizens, and numerous vendor and support companies. We found that coordination was not only made difficult but certain organizations, like the central government were able to impose certificates and other *inscription devices to build an immutable* communication channel that would not 'allow' open source software to communicate with other systems. When such a dictate comes from central government it becomes difficult to create a workaround for local councils, and helps to construct *opacity* through the mechanisms used (like security certificates). Coordination mutability issues also stretched to secondary adopters. The latter drew upon numerous applications to get their everyday work done. One application was seldom used in isolation. This meant that different applications should be able to interface and be integrated when needed. Open source software used by the councils, especially Bristol made integration impossible at times.

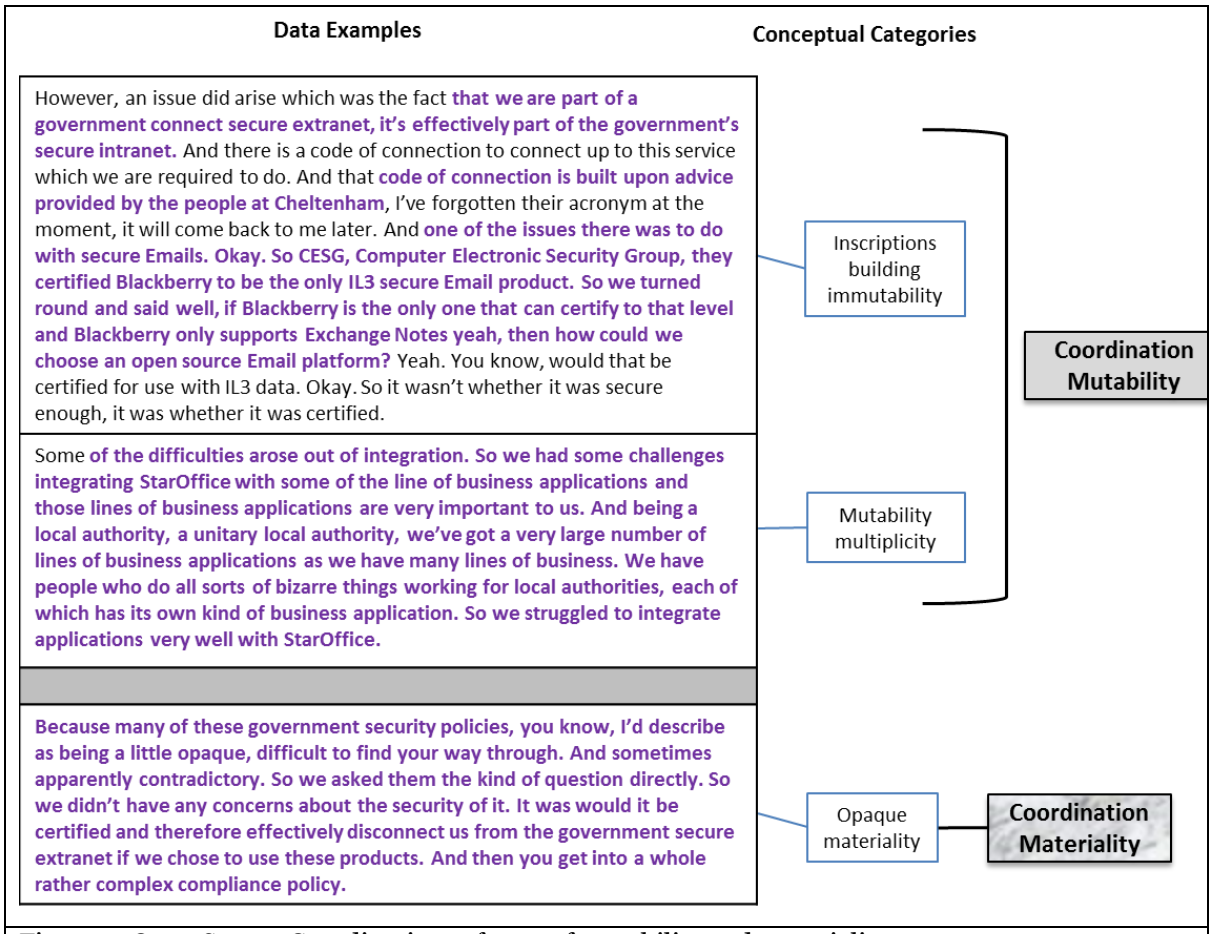

Figure 3: Open Source Coordination – forms of mutability and materiality

5.3 Community

We see quite a clear demarcation between community and how it is understood in primary adoption of open source software, and then secondary adoption (Figure 4). Where primary adoption was concerned our two local councils discussed vendor support as part of the community of an open source product. Support was not seen as reliable, indeed it was *mutable*, problematic, and in very short supply. Both councils had deep concerns about hiring the right people with the right skill set to manage open source

software and servers in their organizations. It was interesting to note that open source software, usually seen as a foil to the usual lock-in that can be created by vendor companies in outsourcing relationships through proprietary software, was just as vulnerable to forming new forms of lock-in – ie created by a lack of good support and talented pool of candidates to hire.

A problem that many open source projects are afflicted with is a diminishing and disengaged community. Our interviewees complained of the same problem and explained the *transit mutability* this created in terms of community members that join a project for a short period of time to gain expertise and some training but once adequately experienced the same developers in the community leave for paid positions elsewhere. The small community size of the average open source project leaves little room for sustainability when new members either don't join or are too hopelessly inexperienced to keep the project afloat on their own.

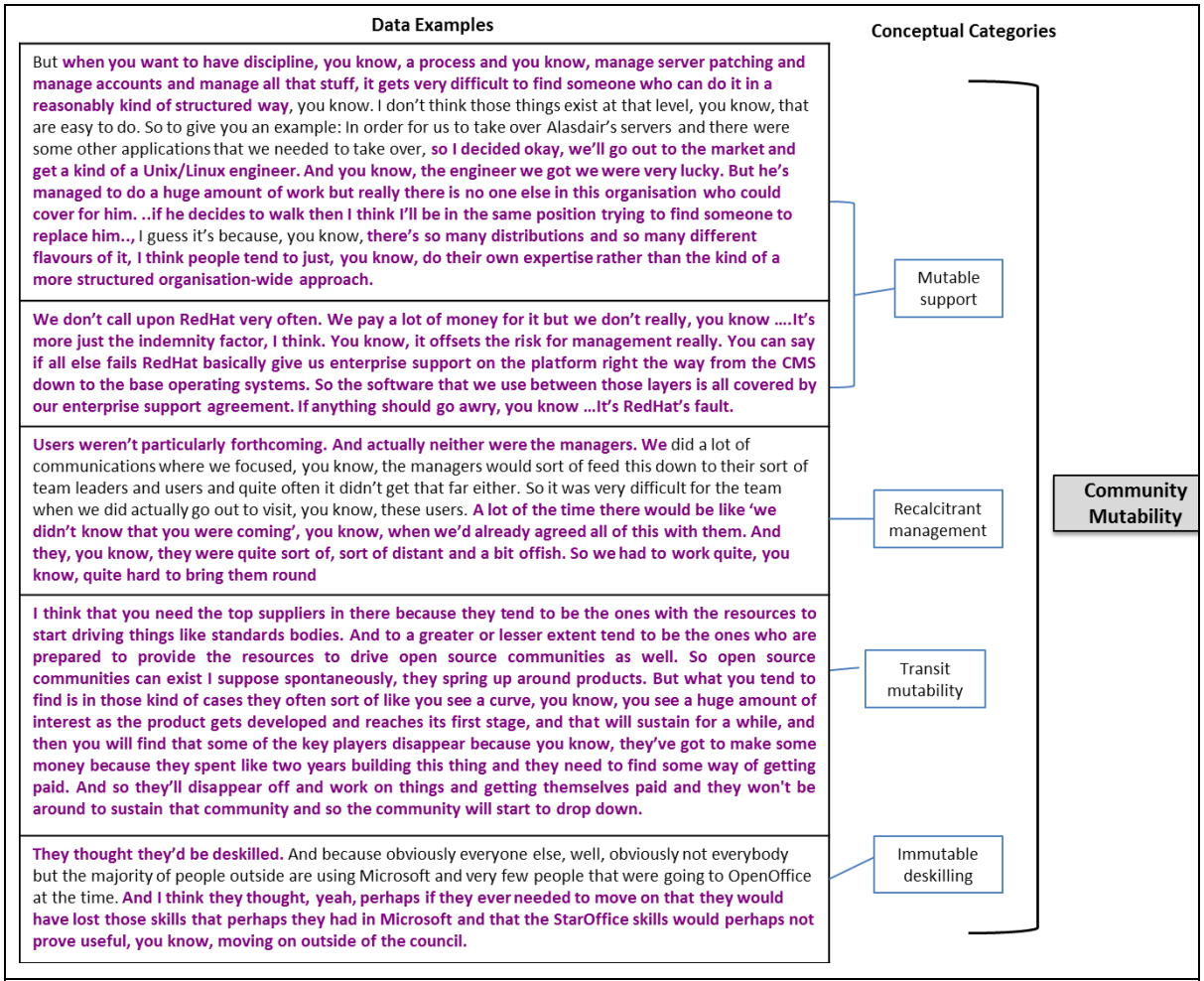

Figure 4: Open Source Community – forms of mutability

At the secondary adoption level our data revealed a *recalcitrant management* and the belief that open source software use would lead to *immutable deskilling* amongst the users. The floor walking teams faced conflict with the new software that they needed to learn how to use, but the harder task was to coral management support to train the users in each department. It is argued that top management

support is necessary to bring about change. The floor walking team faced this dilemma, especially in Bristol City Council though there were serious adoption issues at the secondary level within Camden Council as well. Top management would feign ignorance of appointments set up between them and the floor walking staff to show resistance to the change brought in through open source software roll-out in their departments. Such complications were only made worse when users reacted with the claim that the council and the IT team were helping to permanently and immutably deskill the staff so that they would not be able to seek another job.

5.4 License

License brought up a number of interpretations but the ideas that interviewees focused on were all to do with value and evaluating options (Figure 5). For instance, when deciding on open source software use within the council members of staff explained to us that it was always a technical decision and not a design or ideological one. Gartner was asked to consult and they made recommendations which Camden Council incorporated into practice and made the step between the idea to implementation possible and *immutable*. The other and very key aspect of *value mutability* stemmed from the council's inability to put a value on open source software. How much was the training going to cost, or the migration process itself? These were not questions with easy and ready answers. Unpacking the old processes of doing things including the code being used could also make visible past mistakes. Evaluating the uncertainties and repercussions of such mistakes being made public made the councils yet more fearful to adopt software that was as different as open source. This would bring the contrast and problems into focus.

The materiality of the license was again evident through the various evaluation processes conducted by the council staff (Figure 6). A lack of certification with open source products meant that quality and legitimacy could not be *embedded* into the product through the license. Certification was the *material* stamp that was necessary for products to get adopted and accepted. Choosing an open source product with an appropriate OSI approved license could lead to the ability to *build shared material value* into the product and its new community. Different councils, even across different countries like Brazil and New Zealand used specific open source software for similar tasks. The idea in both Bristol and Camden was that such resources need to be pooled to create greater value. The more interested councils and governments, the more financial help would be pooled into the code to make it better and give it material quality assurance through certification, which in turn could then lead to even more adoption.

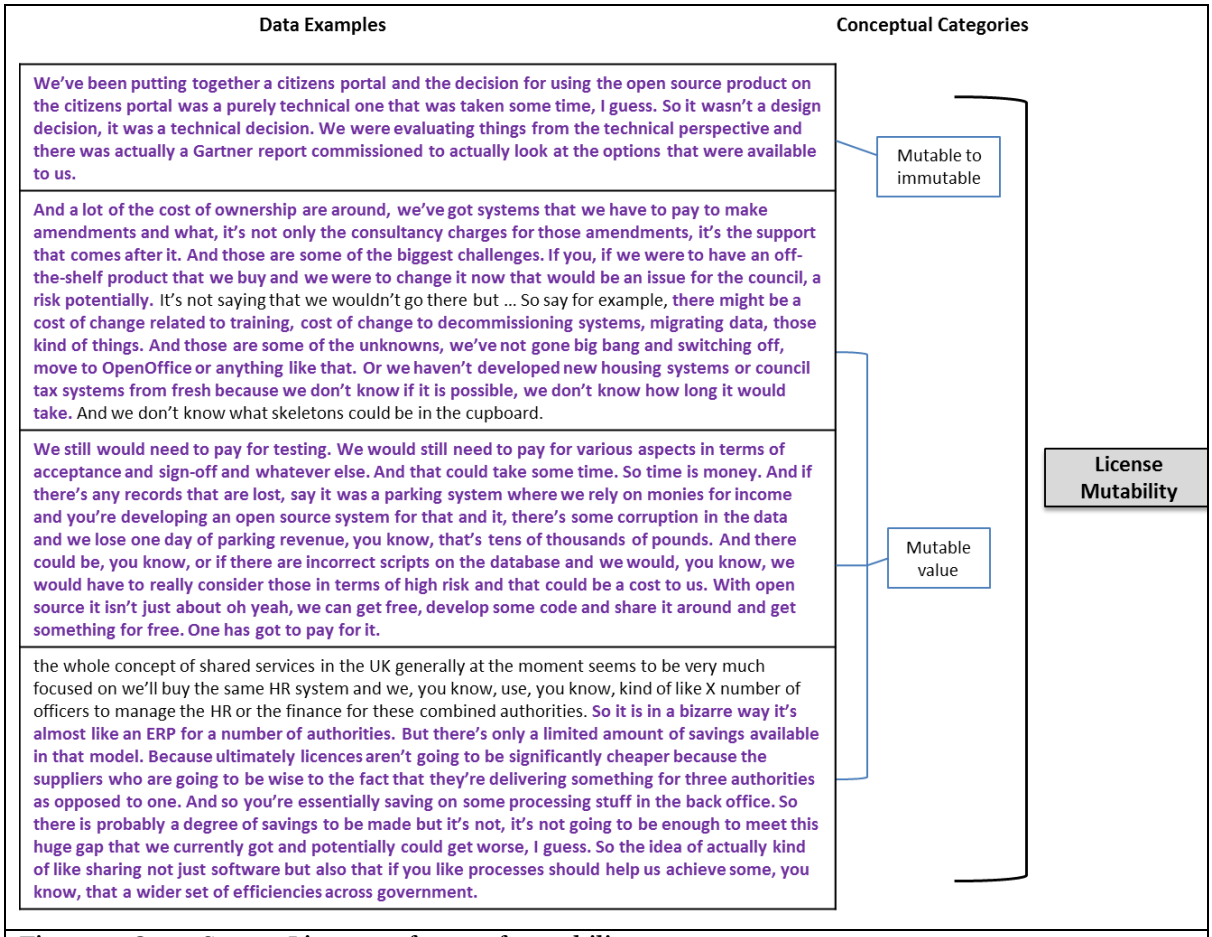

Figure 5: Open Source License – forms of mutability

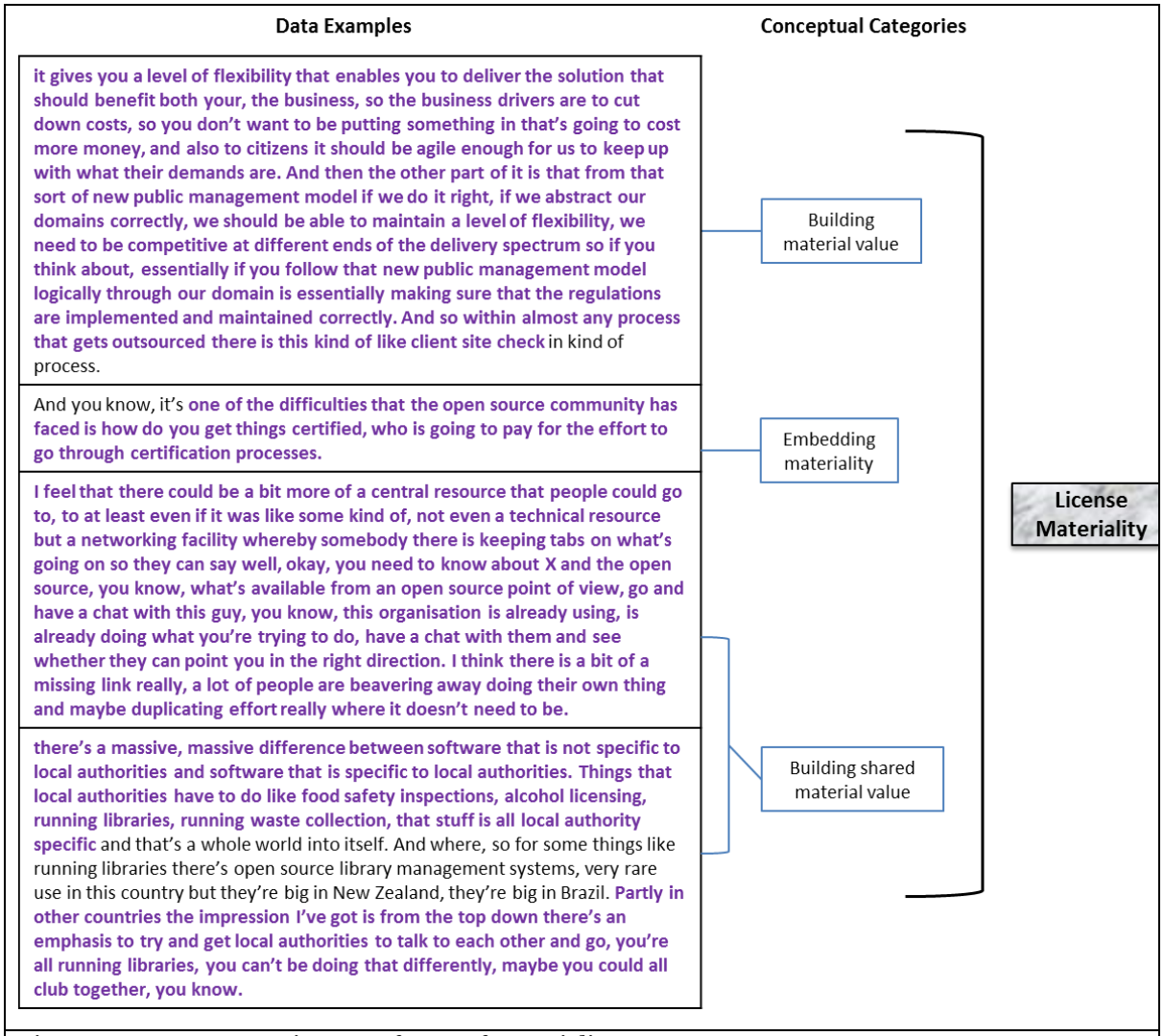

Figure 6: Open Source License – forms of materiality

5.5 Documentation

Documentation for software is always necessary as it makes the code sensible for maintainers, provides training guides for users, and helps to ensure security of the code (besides numerous other benefits). Open source software development is rather infamous for poor documentation, and this was also found in our council's narratives (Figure 7). Documentation, as we noted in our analysis, behaves as an *inscription device* that builds legitimacy but also makes the product and its possible uses *less mutable*. It begins to freeze and fix ideas so much so that drastic change becomes less likely. This is true for primary and secondary adoption.

Like any software contract open source use brought the need for a strong and clearly written SLA to the fore. This was only possible with vendor companies and not with traditional open source communities building software. Vendor companies that supported open source products, as explained above, were not plentiful. And most public sector organizations were also unaware of the possible dangers of open

source adoption and thus less able to write very tight SLA agreements. This made it much harder to *embed material assurance* into the software product through a good SLA.

And finally, at the secondary adoption level the lack of central government support was evident to the IT staff and general users of the software within the councils because the former refused to accept documents and materials in open formats like .odt. The local council staff then had to convert the recalcitrant documents into acceptable formats to send on to the central government but by the time they returned they were less readable. Communication and coordination through such problematic documents with little fidelity made the desire and possibility to adopt open source software less than likely.

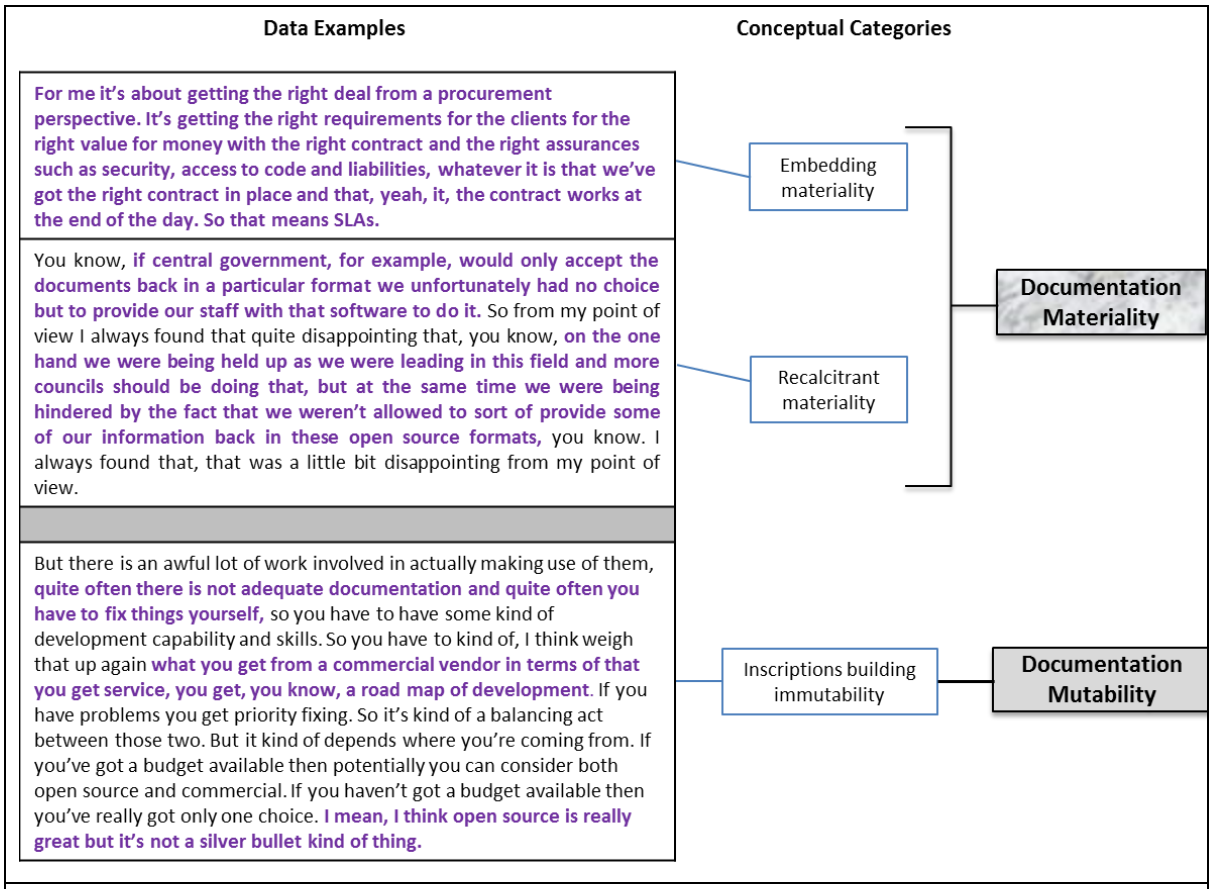

Figure 7: Open Source Documentation – forms of materiality and mutability

6 Discussion

Part of our intrigue with materiality was dictated by our understanding that materiality of various forms had been used, often purposefully, to change the speed (Colville et al. 2012; Weick 2012) of adoption of certain software. Considering the uncertain nature of adoption we were not surprised that both councils had very unique journeys to open source adoption, but what was more interesting was the nature of adoption – how and what can impede or accelerate the process? Our data shows that the becoming of adoption can be both constrained and precipitated by various forms of materiality (of the assemblage

of the open source ecosystem) (Rose and Jones 2004). Open source software and its transparent process, character, code and license does not necessarily lead to more transparency.

6.1 Mutability of Open Source

The two cases, in their own manner, emphasize how malleable and yielding OSS was, and still is (see Table 3). The license of an open source product can range from a variety of accepted (OSI approved) types, however, each license offers some form of viral control mechanism. Some licenses like the General Public License (GPL) are more viral than others. This in turn affects the ability of code to mutate and restricts the variation in becomings possible. The materializing of each element matures the becoming and expedites it in a manner that makes further (variations in) becomings less likely (see Table 3). Thus open source use and adoption can be controlled and managed. In the case of BCC their choice of enterprise open source software was based on an open core model rather than a more 'pure' open source license. Such a model implied that the enterprise edition of the software being procured by BCC was actually not strictly open source as the code was not necessary viewable. Open core models are a form of dual licensing where there is an open source version whose functionality is often limited by comparison to the enterprise open core version, thus giving rise to the term crippleware to describe the reduced functionality OS version. Such choices are becoming more common yet as were told by the developer team, such a model often undermines community contributions eventually killing the project itself.

Community in turn, is a multifaceted phenomenon where variations are visible in the level of skills and expertise of the members and contributors. The size of the community in both cases not only varied but there was a constant flux of developers experienced. Another form of mutability was introduced into the BCC case because it relied on commercial vendor support. Such projects can see diverse forms of sponsorship and resource injection which give rise to changing loyalties, and focus. On the other hand, when questioned about the community support side of their OS project, CC replied that,

> "*I suppose there was and there wasn't. Because there is a community of local government. There are…potentially 399… members of that community. There wasn't at that time any kind of community of webmasters. So there were these relatively new posts being created in local authorities but there wasn't any communication or anything set up to communicate. So that's one of the first things we did as part of the project, we set up five webmasters from the five partners. But then we got them to try and go out and invite people …we did a couple of workshop meetings where we just invited people. So that was the basis of the community*".

Source code, depending on which language is used, the level of application or product being built and its reusability can affect the kinds of mutability possible. As can the variety of coordinating mechanisms at the disposal of a developer community. Much of the discussion about development is carried out over public forums but this is not always true. There is also a growing trend for face-to-face meetings in open source development where traceability of ideas is less transparent and archivable. The various OS projects in both cases used tools such as version control to manage the code, contributions and metadata

as explained by an IT manager at CC, "*the software does have full version control and there is you know, a nightly build that kind of rolls up all of the code contributions and produces the head build as opposed to like a version*" but as he clarified that not all members of the community had equal access to all levels of the tool and code. This again built in varying degrees of transparency and mutability.

Table 3. Implications of Open Source Mutability

Mutability of Open Source becoming *Materialized*

	Areas and Level of Mutability	Implication	Materializing
License	• Choice of license • Version of license • Level of reciprocity involved • Level of transparency	The varied viral nature of some licenses makes them more (or less) amenable to change. Dual licenses are yet another form of mutability.	License is the Constitution – written and in practice. • Changing license • Practicing the license • Implementing the license
Community	• Skill level of members • Core team size • Turnover rate • Number of company backed employees	A community with a strong core team of developers backed by company resources and high skill level has greater potential to adapt and change.	Community traces, voices, decisions, sense of belonging (expressed through T-shirts, brand, etc). • Community in flux • Sponsoring employees • Training of developers
Code	• Level of stack • Reusability • Language • Modularity	Code, depending on which language is used, the level of application or product being built and its reusability can affect the sort of mutability possible.	Code, requirements, functionality and use • Changing requirements • Greater encapsulating • Reusing code
Coordinating Mechanisms	• Public or private discussion groups • Face-to-face meet-ups • Levels and types of mailing lists • Access level of version control software	Coordinating mechanisms in open source are key. Some mechanisms are open to the public, whereas others need to be for developer only access. Such variations in access can blur the level of transparency offered.	Coordinating Mechanisms • Making discussions transparent • Increasing security level of access • Varying governance structure to cope (change) access levels
Documentation and Metadata	• The type of (detail) documentation provided • Level of updating documentation • Access to metadata • Search-ability of documentation and metadata	Documentation in open source can be patchy and incomplete thus eroding transparency and changing the mutable nature of open source.	Documentation and Metadata • Making the search algorithms visible (or not) • Maintaining documentation • Detailed documenting and instructions

6.2 Materializing of Open Source

In table 3 we illustrated how each element of open source software like the license, community, code and so on, encapsulates the potential for more or less mutability. Our two cases of open source adoption by the public sector in the UK narrate this story, and help us to explain the difference in adoption ability and 'success' of both in terms of mutability of open source software, and how this mutability was constrained or encouraged by the material inscriptions adopted for manoeuvre. As much of Science and Technology Studies literature explains materiality is more than tangible 'things', it includes ideas, feelings, and silent action (Akrich and Latour 1992; Law and Mol 1995).

It may well be considered that when anything becomes more materialized that it would be less vague and opaque, however, we found that this was not necessarily true. In fact, there was little ability to trace all the possible trajectories of becoming when the situation was as complex as a politically infused public sector organization. There were more than one possibility for mapping but experienced bureaucrats in both councils were able to manage the possible rupturing of the adoption process. Instead of building transparency into the system with a greater reliance on materiality, the local council IT staff and policy writers were able to contain the opaqueness in a strategic manner to their advantage.

In both councils we saw that license of the software was a key concern. For BCC the open core model created complications and a strong possibility for lock-in. however, it was in its practicing (of the license) that the license materialized. Each license of open source may be slightly different but they are all alike in behaving as the Constitution of the project. As Constitution it dictates what can be done with the code, who owns it and how this ownership can change in processes of redistribution and even multiple licenses. Camden Council adopted a single (as opposed to dual license) and it was the BSD. With the BSD it is possible for anyone to take the source code and change the license of their particular strand. So though the practicing of the license makes open source more material it does little to solidify its mutability thus leaving the possibility of managing the speed of open source adoption. Another manner of understanding such becoming made visible was to make sense of in terms of time (Kavanagh and Araujo 1995). More than license and thus different code branches make visible multiple becomings or multiple parallel times.

The community leaves traces in its process of collaboration, turnover, expertise sharing and so on. Its materializing is manifested in this very change and flux where members join while others leave. Other forms of materializing involve sponsoring employees to become a part of the community, and the training (through the community or on the job) of members. This is part of the process of making open source software prepare for future present time. The possible future is being pulled back in the present becomings to force a certain tracing (not mapping) of the adoption process. This is because the future is unknown so the way the councils made sense of future software and requirement needs was by using the present as indication. However, this becoming was constrained as and constraining as new emergent changes were inevitable – yet by attempting to trace the future both councils were restricting new possibilities.

Speed of becoming is managed through the code by controlling the changing nature of requirements, varied forms of encapsulation and even encouraging reuse of code. These are material forms of the code

where traces are left and can be followed. Code and its materializing thus make it possible to hide time, yet at the same revisit time. Camden Council was hopeful of reusing its code and system across other councils and did manage this for a while, "*and so we built our proposal to the funding around that basis that we were going to produce an open source content management system that would be reused by other local authorities… And so that release got taken up by more than 30 UK local authorities and then started being taken up in Australia and Malaysia and China and all kinds of places in the world*". However, a shrinking ecosystem of vendor support over time made a change in code less possible. This in turn led to impaired materializing of the code, and the objectives of Camden Council.

Traceability and materializing in relation to open source coordination are (theoretically) built into the open development process. Discussions between developers are made visible, and traceable, access to discussion forums and version control software are managed by security levels, and we also found in our data that the governance structure changes in relation to security access and expertise of the developer. The materiality of code makes time traceable and retraceable (though each retracing will no doubt be a variation of other becomings and not quite a tracing).

Finally, time, or moments of it can be captured. This reinforces the idea of materializing of open source because good documentation of code makes algorithms visible, and future documentation easier and more possible. However, as the example of BCC shows poor documentation, and impaired interoperability can force a breakdown of software use. The fact that other councils that BCC needed to work with did not use open source made it difficult for BCC to share documents without trouble. Often the documents created by BCC using open source were not rendered in the expected manner by other councils or were completely illegible, "*we had an issue with document fidelity – documents would not display as they were intended to in the open source application*". Considering each element of open source individually is useful to understand mutability, materializing and transparency (or lack of) but as one interviewee explained open source is complex and has 'vectors of lock-in'. It is an entanglement of all these elements in proportions that are beyond complete control that build in uncertainty make the becoming of open source software so challenging. The data revealed richness in its material element (as the codes show).

6.3 Theoretical Implications

Materiality and mutability are key ideas in Science and Technology Studies. The fluid nature of software makes it a very relevant and interesting phenomenon to focus on in this regard (Mol and Law 1994; Moser and Law 2006). Software, especially open source software is more fluid because it is accepted that it will be in constant change and upgrade (Fang and Neufeld 2009; Fitzgerald and Agerfalk 2005; Fitzgerald and Feller 2002). Literature on open source procurement and adoption in the public sector has not only ignored this idea but we find that it is in general (though not true for all) often atheoretical. We have attempted to redress this issue by sensitizing our data collection and analysis with ideas of becoming. Such an ontology allowed us to move beyond a focus on only the human (Feldman 2000), or practices, or likening change to improvising (Orlikowski 1996). There has been more recent work in IS that shows concern for a relational ontology where the social and material are understood to be

entangled (Orlikowski and Scott 2008) and imbricated (Leonardi and Barley 2008) but there has been little use of such ideas to understand OSS in the public sector, and how this implicates the process of becoming.

While Freeman's (2012) work, like ours, does take a science and technology perspective it focuses on discourse to build an analysis of different and competing narratives that emerged in the Finnish public sector with respect to open source software. Our work instead is interested in the changing nature of materiality of open source and its multiple facets. We zoom into the narratives at two different layers to show conflict, and re-materialization of open source software. So our work is complementary to this and other related studies.

The work by Mengiste and Aanestad (2013) provided some interesting insights into the complicated role that customization of software can play in bringing about shared learning and understanding. And though our work does in part discuss customization of open source software by both local councils this is not our real focus. Instead, we show how various different aspects intrinsic to open source are able to mutate thus leading to a possible change in nature of the open source software, and its adoption. Our work, like Allen and Geller's (2012) does in part study the changing nature of relationship between the IT staff and users. Our work found that the floor walking team was very influential in changing the way open source software was viewed, and used by the users. At the same time the process of negotiating user queries allowed the IT staff to become better acquainted with the users and vice versa. Deepening respect for each other was a positive outcome of this process. How our study differs is that we focus on the materiality of the software and how this was able to re-negotiate a new understanding of open source software.

This is again different from the study by Huysman et al (2008) because as the authors explain the reason why non-adoption should be studied is that sometimes, as in the Belgian case certain software is rejected for more simple but very relevant reasons such as the software just simply doesn't have the right functionality or makes it impossible to interface between users working with different software packages. We saw this emerge in the Bristol City Council case when StarOffice was used and the package would not allow for seamless sharing of documents between different users. Where our study differs and complements this work is with our unpacking of the software, and the implications of it being open source software.

Our study has policy implications for various governments around the world that are moving towards open source software adoption in the public sector. We show that open, simply the word alone, does not necessarily lead to benefits of openness in governance, software development process, removal of hierarchy, or positive results in engaging with public sector employees or even citizens. Open source adoption like other technologies needs to be approached carefully and with expertise in order to reap the benefits of reduced lock-in, lower costs of implementation and license, and greater transparency.

6.4 Policy Implications

This research raises implications for policies that could be amended or put into place to improve the adoption of open source software in the public sector. To clarify, open source software may not be the best solution in every context but a better understanding of what it offers is necessary so that more suitable decision-making is possible. Reflecting on what was learnt during this study we suggest the following recommendations for policy:

Encourage creation and use of open source expert consultants that can then be used as a resource across different local councils and central government. We already note from the Camden Council case that their IT manager was eager to provide such a service to Bristol City Council and beyond. There needs to be a coordinated effort to build such expertise, recognize it and to use it effectively when software decisions are being made across the government. There would be an added advantage to retaining and nurturing such a pool of experts within the government – such consultants would be in an ideal position to *reuse* software, *customize* it for different contexts, but most importantly, they would be the team most likely to *innovate* with products and software.

Encourage adoption of open standards as well as open source software because very importantly this step will limit the mutability that can be manipulated in open source software use. Open source software adoption is very important but this needs to be coupled with the use of open standards to keep the code and practices around the software *open* and *transparent*.

Encourage primary adoption of open source before moving to secondary adoption as the latter entails training across your employees and even customers. To be able to negotiate a change in software use at such a broad level is rarely successful if attempted all at once. It needs to be staged and phased in with the keenest adopters being drawn in first to create momentum and goodwill for the change. The idea behind favouring primary adoption before any level of secondary adoption is that your IT personnel are more likely to be agnostic to the license of a tool to be adopted and rather they focus on its pragmatic usability. There will be a need for your IT staff to become the trainers of your secondary adopters so clearly this is a prerequisite in the process of adoption.

Encourage education and awareness around exit costs of legacy systems so as not to unduly prejudice the adoption of open source software. In our study we found that many public sector officials were unaware of the idea of exit costs and had shown an eagerness to relate them purely to open source adoption. There was little recognition that exist costs are indeed a condition of all software changes on a large scale, be it proprietary or open source software. Awareness could be stretched to demonstrating how open source software could reduce *vendor lock-in* and *license costs*, thus reducing expense in the long-term (unlike with proprietary software).

Encourage the growth of vendors and suppliers that are in a position to service open source products to create a necessary ecosystem of support for products. Open source, like proprietary software requires detailed documentation, quality assurance, certification schemes, training, and support services. One of the deterrents, we were told by interviewees in both cases, was the lack of support for open source products in the market. This situation was exacerbated in Camden, an innovative team of developers who were keen to do new and interesting things, being siphoned off into maintenance jobs for other

councils. There was a growing sense of demoralization because their skills could have been put to better use. To build a *sustainable* ecosystem and long-term growth for open source products in the public sector it is essential that a healthy ecosystem of small and medium sized firms are stimulated to service public sector open source products.

7 Limitations and Future Directions

In summary our main theoretical contribution is an understanding of how the *becoming* of open source software adoption by two different local councils in the UK indicates that the process of becoming occurs at different speeds because of the nature of their materiality. The success and failure of open source adoption was deeply affected in both cases by the different facets of open source and how they were massaged and manipulated to achieve particular ends. The theoretical idea is that the becoming of adoption can be both constrained and precipitated by various forms of software materiality (of the assemblage of the open source ecosystem) (Rose and Jones 2004). All software is mutable but there are particular material features of open source software that make it very mutable. And, the interesting point of departure of our study is how open source software – a much touted transparent and open phenomenon – is by its nuanced and layered mutability (Mol and Law 1994; Moser and Law 2006) able to make the process and practices surrounding it less visible.

The idea of transparency and openness in open source has not been theorized to date and this work contributed directly to that issue and how to manage the adoption of open source software in the public sector. The latter has practical and policy implications. Our main practical contribution is a set of policy recommendations about open source adoption in the public sector. Our ideas resonated with others in this area (Bouras *et al.* 2014) yet we also complement their work with very local and context-specific recommendations (i.e. the ability to contextualize policies for local use).

However, this work is not without its limitations. Firstly, proprietary software faces its own adoption concerns and some may well overlap with those of open source software. However, we understand with the particular angle on the different facets of what it means to be open source software that we have investigated in this paper reflect that there are some keen distinguishing factors. So for example there is some overlap in a need for documentation but it is acknowledged that this is a far more serious concern for open source software. And license differences are actually very stark for both types of software.

Secondly, it would have been useful to have been able to map the progression of one or more open source software packages in the local councils from inception to post- implementation stage to map mutations in the code, usage, process of development and even the implementation. This could potentially have given rise to even more detailed data and results with respect to the materiality and mutability of open source software.

Thirdly, both our cases are local councils but it could be argued that this phenomenon could have been present in non-government organizations as well. Ideas of mutability and materiality could well be

tested in other contexts. At the same time we believe there is something specific and particular about the public sector that makes it more averse to change and quite rigid in nature.

Our future research agenda involves the above as well mapping the links of open source with open data, open standards and open government. How do these ideas work in tandem and to what effect? It is acknowledged and understood that open standards are a necessity with open source software use as the former help to maintain the openness of open source software. Yet, we are also keen to explore facets of open government, how to conceptualize open government in relation to e-government, and the New Public Management (NPM) agenda. The idea that open government has led to multiple, and interesting community based ventures such as crowdsourcing for information attracts our attention and potentially yields useful research questions. Thus our work has interest for academics interested in open source adoption by the public sector but also those that are keen to theorize various aspects of open source. Our policy recommendations stem from our personal experience with both councils in this study and beyond. We are able to make a clear contribution to practice through our policy recommendations.

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